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Rapid Communication

First record of invasive aquatic plant *Ludwigia peploides* (Onagraceae) in the Danube Delta, Romania

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Abstract

This study documents the first confirmed record of *Ludwigia peploides* (Onagraceae) in the Danube Delta, Romania. It evaluates the potential ecological implications of its establishment in this internationally significant wetland system. The species was detected, by chance, in 2025 during a targeted floristic survey conducted within a project focused on the improvement of water circulation through hydrotechnical works. Field investigations included detailed habitat assessments, vegetation sampling using the Braun–Blanquet approach, and laboratory verification of collected specimens. The newly identified populations appeared in shallow freshwater channels and temporarily flooded reed margins, forming dense, mat-like stands typical of the species' invasive behaviour in other European regions. In addition to confirming the species' presence, this study characterises its local abundance, distribution, and growth patterns, and highlights environmental conditions that favour its spread. The analysis shows that *L. peploides* exhibits clear traits of high invasive potential, rapid vegetative propagation, tolerance of water-level fluctuations, and ability to outcompete native macrophytes. Given the Danube Delta's vulnerability to biological invasions and its status as a UNESCO Biosphere Reserve, the appearance of this species raises concerns regarding possible impacts on hydrology, biodiversity, and wetland functioning. The findings underscore the need for early, site-based management interventions, including delimitation surveys, rapid removal of newly established peripheral patches where feasible, and follow-up monitoring, together with systematic mapping of local occurrences to support rapid response within the Danube Delta.

Key words: macrophyte invasions, early detection, wetland management, rapid response

Introduction

Aquatic plant invasions represent a growing threat to freshwater ecosystems across Europe that reduces native biodiversity and alters ecosystem functioning. Among these, the floating primrose-willow (*Ludwigia peploides*) has emerged as one of the most problematic aquatic invaders in Europe due to its ability to form dense, monospecific mats that modify hydrology and water quality (Dandelot et al. 2005; Thouvenot et al. 2013). *Ludwigia peploides* (Kunth) P.H. Raven, the species is native to shallow floodplain margins, marshes, wet mud, and slow-moving freshwater

habitats in South and Central America and belonging to the *Ludwigia uruguayensis* species complex, is one of the most problematic taxa in this group and is now exhibiting invasive behaviour in multiple European regions (Dandelot et al. 2005; Jo et al. 2024) which strengthens the ecological context for its establishment in the Danube Delta. The species was introduced to Europe in the 19th century, primarily through ornamental horticulture and has since established naturalised populations in France, Belgium, the Netherlands, Italy and Spain (Dandelot et al. 2005; Gori et al. 2023). Its success is facilitated by prolific vegetative reproduction, rapid lateral spread, and tolerance of fluctuating hydrological conditions (Hussner 2010).

Experimental and field studies have shown that *L. peploides* exhibits strong growth responses across various nutrient regimes, develops extensive root systems, and can shift between submerged and emergent growth depending on water-level dynamics, indicating the ability to grow in both aquatic and temporarily terrestrial habitats (Hussner 2010). Allelopathic effects demonstrated for invasive *L. peploides* may further suppress native macrophytes and enhance their own invasiveness (Dandelot et al. 2008). These traits contribute to the formation of dense, often impenetrable mats that reduce light penetration, lower dissolved oxygen, obstruct water flow, and degrade native aquatic habitats (Dandelot et al. 2005; Thouvenot et al. 2013).

In Italy, invasion-curve analyses and species distribution modelling indicate that extensive areas of the peninsula provide a climate suitable for *L. peploides*, suggesting substantial invasion potential under future scenarios (Gori et al. 2023). The species has also been reported in the Balkans, including Greece (Zotos et al. 2006). Following the EPPO pest risk analysis (EPPO 2011), *Ludwigia peploides* was subsequently included in the Union List of Invasive Alien Species under Regulation (EU) No 1143/2014 (European Commission 2016).

Beyond Europe, the species has recently spread rapidly in South Korea, forming high-density populations in reservoirs and along river margins, confirming its global invasive capacity (Jo et al. 2024). Likewise, in South America, *Ludwigia*-dominated vegetation is formally recognised as "Ludwigia communities" (PHYSIS habitat type 22.341; Institute of Terrestrial Ecology 1996), in which *L. peploides* co-occurs with other creeping or floating species in shallow-water and wet-mud environments.

In Romania, *L. peploides* has only recently been detected. The first confirmable national record was published by Sîrbu et al. (2021b), who reported dense populations along the Sâi River and highlighted potential risks for Natura 2000 wetland habitats. National inventories now list the species as present but still restricted in distribution (Sîrbu et al. 2021a; Anastasiu et al. 2024). Despite these findings, there have been no published

reports of *L. peploides* from the Danube Delta**,** a major European wetland complex and biodiversity hotspot considered highly vulnerable to invasive aquatic macrophytes. Given the invasive history of *L. peploides* in other European freshwater systems and the ecological sensitivity of the Danube Delta Biosphere Reserve, documenting new incursions is essential for early detection and management. This study provides the first confirmed record of *Ludwigia peploides* in the Danube Delta (Romania). These similarities in habitat setting and vegetation structure indicate that the Danube Delta populations fit well within the broader ecological profile of the species, which typically invades ecotonal habitats at the land-water interface. The composition of the associated macrophyte flora, together with the high cover values recorded in our relevés, suggests that *L. peploides* is already functioning as a structural dominator within parts of the delta, much as observed in other invaded wetlands worldwide. We describe the occurrence, ecological setting and associated vegetation, and discuss potential implications for future spread and wetland management within this protected region.

Materials and methods

Vegetation sampling was conducted using the Braun–Blanquet phytosociological method. A total of 10 relevés dominated by *Ludwigia peploides* were recorded along a secondary channel of the Danube Delta (Șontea Nouă channel – Candura sector) during September-November of 2025. Each relevé covered a standard surface area of 25 m^2 (5 × 5 m), corresponding to the spatial scale typically used for hydrophytic vegetation. Visual shoreline inspections were combined with boat-based surveys along aquatic margins. Once populations were detected, their extent was mapped, and co-occurring species were recorded. For each relevé, the following environmental variables were measured *in situ*: total vegetation cover (%), water depth (cm), and Secchi-based water transparency (cm). Geographic coordinates (WGS84) were recorded using a handheld GPS unit (Garmin Montana 750i) with a precision of ± 5 m. Distribution maps were later compiled using QGIS (version 3.34).

Species abundances were estimated using the Braun–Blanquet cover–abundance scale and later arranged both in syntaxonomic order following Mucina et al. (2016) EuroVegChecklist and in functional ecological groups. Floating, submerged, and creeping emergent (*L. peploides*) macrophytes were all included. Taxonomic nomenclature follows Euro+Med PlantBase. Plant material of *L. peploides* was collected. Voucher specimens were pressed, dried, and deposited in the "Anastasie Fătu" Botanical Garden herbarium of Iași (IAGB - 47936), available for future verification. Taxonomic attribution follows current nomenclature and species concepts accepted by the Global Biodiversity Information Facility (GBIF).

Results

The analysed relevés show a vegetation complex structurally dominated by *Ludwigia peploides*, whose creeping-emergent growth form enables the development of dense mats across a broad gradient of water depths (40–210 cm). Syntaxonomically, the assemblages correspond primarily to communities of the classes Lemnetea and Potametea accounted for most of the associated species diversity. Emergent helophytes typical of Phragmito-Magnocaricetea, such as *Phragmites australis* and *Typha angustifolia*, were not recorded within the sampled plots, although they were common immediately adjacent to the *Ludwigia* stands and likely provided a shoreline framework from which *L. peploides* extended into open water. Functionally, the sampled stands were strongly asymmetric, with *L. peploides* as the only dominant emergent species, while the remaining taxa were represented mainly by low-cover floating (e.g. *Lemna minor*, *Azolla filiculoides*, *Salvinia natans*) or submerged macrophytes (e.g. *Ceratophyllum demersum*, *Myriophyllum spicatum*). This pattern indicates that the invaded areas represent the open-water fringe of reed and bulrush belts, where *L. peploides* forms dense mats across the water surface and may alter local light availability and stand structure.

The species' competitive traits, rapid expansion, floating formation, and tolerance to varied hydrological conditions, suggest that mat-forming invasions can significantly alter the composition and vertical zonation of native aquatic vegetation, thus directly competing with *Nuphar luteum* and *Nymphaea candida* stands frequently found in the area, identified as *Myriophyllo verticillati-Nupharetum luteae* Koch 1926 and *Nymphaeetum albo-candidae* (Hejny 1950) Passarge 1957 plant communities.

Ludwigia peploides (Kunth) P.H.Raven in the Danube Delta, Romania (Figures 1–4)

All populations occur in lowland freshwater habitats with slow-moving or stagnant water and gently sloping muddy margins, entirely consistent with the ecological preferences reported elsewhere in Europe. Along Șontea Nouă channel, *L. peploides* forms dense floating to emergent mats in sheltered inlets and along the inner banks of meanders, usually immediately in front of belts of *Typha angustifolia*, *Phragmites australis* and *Salix alba*/*S. cinerea*. Here, ten relevés were recorded on the channel between 45.261721°N/29.0059208°E and 45.2483213°N/29.0772553°E (Table 1).

Species are arranged according to EuroVegChecklist syntaxonomic classes (Lemnetea, Potametea, Phragmito–Magnocaricetea). Cover–abundance values follow the Braun-Blanquet scale. K = constancy class calculated across 10 relevés. Environmental variables (total vegetation cover, water depth, Secchi depth) are given above each relevé column. All associated species recorded in or near to the sampled stands are displayed; *Phragmites*

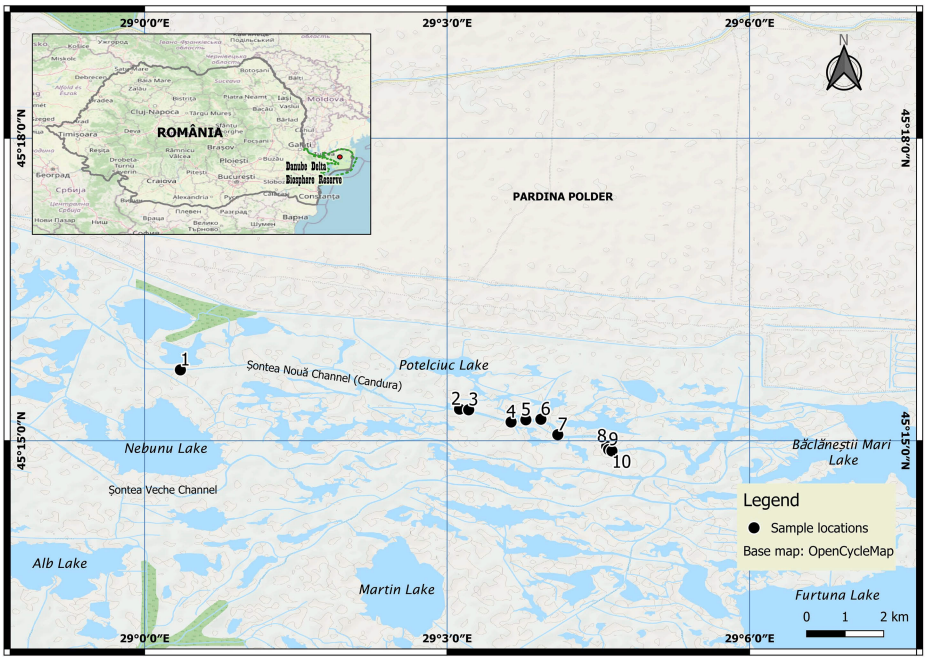


Figure 1. Sampling locations for the ten *Ludwigia peploides*-dominated relevés on Șontea Nouă channel – Candura sector (Danube Delta) (10 relevés). The map displays the local-scale distribution of surveyed aquatic vegetation stands.



Figure 2. *Ludwigia peploides* on Șontea Nouă channel (Danube Delta), November 2025, M. Doroftei.

australis and *Typha angustifolia* are mentioned in the table to show the adjacent helophyte fringe, although they were absent from the sampled plots themselves.

Total vegetation cover in these plots ranged from 60 to 90% (mean 79%), with *L. peploides* cover–abundance values of 3–5 (Braun–Blanquet), indicating a clear dominance of the species. Water depth at the relevé sites ranged from 40 to 210 cm (mean ca. 1.2 m), while Secchi transparency ranged from 20 to 100 cm (mean 62 cm). The species typically occupied the interface between emergent helophyte stands and open water. Stands along lesser bulrush beds (*Typhetum angustifoliae* Pignatti 1953), reedbeds (*Scirpo-Phragmitetum* W. Koch 1926) and willow fringes (*Salicetum albae* Issler 1924) were frequent, suggesting a preference for disturbed, well-lit marginal zones with fluctuating water levels. In some sectors, *L. peploides*



Figure 3. *Ludwigia peploides* in dense mat-formation above the water (Danube Delta), October 2025, S. Covaliov.



Figure 4. *Ludwigia peploides* fruits (A) and seeds (B) detail, November 2025, S. Covaliov.

formed nearly monospecific carpets extending several metres from the shore into the channel, overgrowing submerged vegetation and trapping organic debris which could lead to channel clogging and decreasing water circulation. Across all relevés, *L. peploides* co-occurred with a diverse assemblage of floating and submerged macrophytes. Common accompanying species included *Azolla filiculoides*, *Lemna minor*, *L. trisulca*, *Salvinia natans*, *Spirodela polyrhiza, Ceratophyllum demersum*, *C. submersum*, *Myriophyllum spicatum*, *Nuphar lutea* and *Trapa natans*. Shannon–Wiener diversity (H′), calculated using presence/absence data for associated species, ranged from 1.10 to 2.20 across the ten relevés and closely tracked variation in species richness (S = 3–9). Pearson correlations showed that *L. peploides* dominance (AD) was positively associated with water depth ($r = 0.69$, $p = 0.026$) and total vegetation cover ($r = 0.63$, $p = 0.05$), but not with water transparency ($r = 0.18$, $p = 0.62$). Species richness was significantly and negatively related to water transparency ($r = –0.65$, $p = 0.042$), while its

Table 1. Syntaxonomic phytosociological table of aquatic vegetation dominated by *Ludwigia peploides* in the Danube Delta (relevés 1–10).

Relevé no.	1	2	3	4	5	6	7	8	9	10	
Cover (%) from 25 m²	85	85	75	60	75	90	90	70	70	90	K
Depth (cm)	40	210	190	40	75	40	180	100	180	150	
Secchi depth (cm)	30	40	40	40	75	40	80	100	100	100	
Floating (%)	66.7	62.5	62.5	66.7	62.5	66.7	62.5	50	50	50	
Submerged (%)	22.2	25	25	22.2	25	16.7	25	33.3	33.3	25	
Ludwigia peploides (Kunth) P.H.Raven	4	5	4	3	4	4	5	3	5	5	V
CLASS LEMNETEA (floating macrophytes)											
Azolla filiculoides Lam.	+	+	+	+	+	+	+	+	+	–	V
Lemna minor L.	+	+	+	+	+	+	+	+	+	+	V
Lemna trisulca L.	+	+	+	–	+	+	+	–	–	–	IV
Lemna minuta Kunth	+	–	–	+	–	+	–	–	–	–	II
Spirodela polyrhiza (L.) Schleid.	–	–	–	+	+	–	–	–	–	–	I
Salvinia natans (L.) All.	+	–	+	+	–	–	+	+	–	–	III
Trapa natans L.	+	+	–	+	+	–	–	–	–	–	II
CLASS POTAMETEA (submerged macrophytes)											
Ceratophyllum submersum L.	+	+	+	–	–	–	–	–	+	+	III
Ceratophyllum demersum L.	–	–	–	+	+	+	+	+	–	–	III
Myriophyllum spicatum L.	+	+	+	–	+	–	+	–	–	–	III
Potamogeton lucens L.	–	–	–	+	–	–	–	+	+	–	II
Nuphar lutea (L.) Sm.	–	+	+	–	–	–	+	–	+	+	III
CLASS PHRAGMITO–MAGNOCARICETEA (helophytes)											
Phragmites australis	–	–	–	–	–	–	–	–	–	–	–
Typha angustifolia	–	–	–	–	–	–	–	–	–	–	–

relationships with *L. peploides* dominance, depth and total cover were not significant ($|r| < 0.25$, $p > 0.05$).

The accompanying species recorded in the Danube Delta relevés show a strong resemblance to plant assemblages documented in other regions where *Ludwigia peploides* has established populations. The presence of *these species* reflects a nutrient-rich, slow-flowing to stagnant macrophyte community, typical of floodplain channels and shallow lakes. The high cover values of *L. peploides* and its frequent association with eutrophic, structurally altered shorelines indicate that the species is already naturalised and locally invasive in the studied sector of the Danube Delta.

Herbarium specimens

ROMANIA. Tulcea County, Danube Delta, Şontea Nouă channel (Candura sector), dense floating mats in front of lesser bulrush and reed stands (*Typhetum angustifoliae* Pignatti 1953; *Scirpo-Phragmitetum* W. Koch 1926), 45.2552° N, 29.0521° E, water depth 2.1 m, 2025, leg. [Doroftei Mihai and Covaliov Silviu], voucher deposited in the Herbarium of ["Anastasie Fătu" Botanical Garden within "Alexandru Ioan Cuza" University of Iași], acronym and accession no. [IAGB-47936] (herbarium acronym according to Thiers 2019).

Discussion and conclusions

The first populations of *Ludwigia peploides* were discovered quite by chance on Şontea Nouă channel (Candura sector). To obtain a better

understanding of the species' distribution, a more targeted search was conducted in locations and habitats (EUNIS C1.32 and C1.33) that appeared suitable for the species. Therefore, a larger area of the channel network between Nebunu, Martin, Băclănești and Potelciuc lakes was investigated. These sites represent a mosaic of lotic and lentic environments characterised by fluctuating hydrological regimes, high nutrient loads, and dense macrophyte communities, conditions favourable for the establishment of invasive plants. Initial findings were based on exploratory searches (Șontea sites), followed by targeted investigations in habitats deemed suitable for colonisation, in accordance with the approach used for other European invasion reports.

The biological and ecological traits of *Ludwigia peploides* clearly distinguish it as a highly opportunistic creeping emergent macrophyte capable of rapid growth, efficient nutrient uptake and fast decomposition in nutrient-enriched aquatic environments. Across field surveys *L. peploides* consistently exhibited high biomass production. Its ability to regenerate vigorously, even after severe biomass removal, further reinforces its resilience in disturbed habitats. A key attribute of *L. peploides* is its relatively rapid decomposition rate (Rejmánková 1992). Collectively, these traits illustrate how *L. peploides* can expand vigorously in anthropogenically enriched waterways, maintain dense mats, and persist under frequent disturbance, particularly by reed burning and boat traffic, positioning it as a species with substantial ecological and management implications in modified freshwater systems.

One of the main drivers of the species' invasion in the study area is hydrotechnical work on channels aimed at improving water circulation. During such works, the sediments along with natural vegetation are dislodged in order to deepen the channel bed. Channels near study sites that have been under these hydrotechnical works—Arhipenco, Șontea, Stipoc, Furtuna, Razboinița and Bogdaproste—are habitats prone to the future spread of *L. peploides*. Here, the species colonises muddy substrates exposed during slight water-level drawdowns and rapidly extends into adjacent shallow water. Although quantitative data are more limited than for Șontea Nouă channel, field observations indicate similar dominance patterns, with *L. peploides* overgrowing native floating-leaved *Nuphar luteum* and submerged vegetation *Ceratophyllum demersum* and locally forming continuous belts along the shoreline.

Taken together, our records demonstrate that *L. peploides* is established in hydrologically connected water bodies in the Șontea Nouă channel (Candura sector) and it will continue downstream into the channel network via the described drivers. The combination of a suitable climate, extensive networks of stagnant and slow-moving waters, high nutrient loads, and frequent physical disturbance suggest a high likelihood of further spread within the delta if no management actions are undertaken.

We recommend: a rapid delimitation surveys around the known occurrence; repeated monitoring during the growing season; early mechanical removal of small patches before fragmentation and fruiting and special caution during hydrotechnical works, which may facilitate fragment dispersal.

Authors' contribution

Research conceptualisation: MD. Data collection: MD, SC, GL and YK. Writing first draft: MD. Reviewing and editing the first draft: SC, GL, KK and YK.

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Data availability

Species georeferenced records are available at the European Alien Species Information Network: https://easin.jrc.ec.europa.eu/easin/RJD/Download/facb250c-2c06-4aa6-a410-5913d5eb0ee1.

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